# THE NIH COMPUTER UTILITY

## Yesterday & Today

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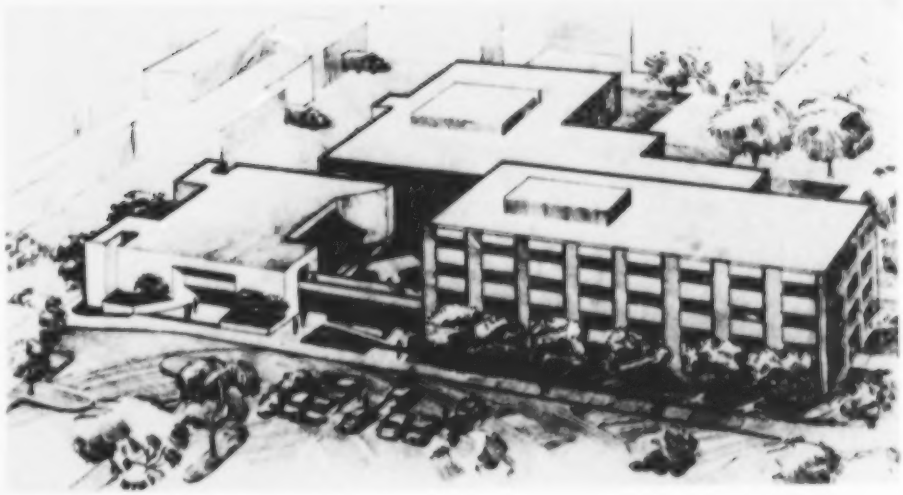
*The text of this brochure presents the NIH Computer Utility from its beginning to the present. The picture timeline reflects this theme by tracing the development of computing devices in the United States from early adding machines to the complex multisystems that make today's Computer Utility possible.*

*Our cover poses the question: "What if yesterday met today?" Upon consideration, we're sure that that inventive genius, Ben Franklin, would gladly have set aside his quill pen for the latest in online text editors for his work as editor of "Poor Richard's Almanac" and the "Declaration of Independence."*

# Environment

Established in 1930, the National Institutes of Health (NIH) is the agency of the federal government responsible for the conduct and support of research in the biomedical sciences. The headquarters, located on a 300 acre campus in Bethesda, Maryland, includes a 500 bed research hospital and some 50 buildings containing the most modern biomedical research laboratories and support facilities in the world. About half of the more than 10,000 employees of the NIH are directly engaged in research in such areas as cancer, heart disease, arthritis, and child health. Many of the remainder are engaged in the distribution of contracts and grants to universities, hospitals, medical schools, and research institutes to support biomedical research throughout the United States. Nearly 175,000 non-federal scientists at more than 10,000 different institutions have received direct support from this NIH outreach. Computer services necessary to support this complex facility are provided by the Computer Center, a branch of the Division of Computer Research and Technology.



# History and Mission

The first computer, an IBM 650, was installed at NIH in 1958. It was an experimental device and, at first, its practical functions as a research tool were largely unexplored. During the next six years useful applications increased, and researchers found that computers could make a vital contribution to mathematical biomedical research. As machine use grew, and computers became an integral part of the scientist's laboratory equipment, it became clear that biomedical computing required a strong mathematical and technical base.

In order to meet this need, the Division of Computer Research and Technology (DCRT) was created in 1965. Its staff, representing professional disciplines ranging from chemistry, engineering and medicine to the information sciences, is responsible for implementing a two-fold mission:

—to provide cost-effective computer services and technical advice in support of the scientific research and management programs of the NIH.

—to conduct research and develop programs in theoretical and applied mathematics, physical sciences, mathematical statistics, and the information sciences.

The NIH Computer Center addresses itself to the former objective by the design, implementation, and operation of a comprehensive multi-faceted Computer Utility. The Center's goal is to bring computational power into the laboratories and offices of researchers and administrators when and where it is needed.

# Growth and Development

In 1967, the NIH Computer Utility consisted of two IBM 360/50 computers. They handled an average of 43 jobs per day in batch mode only; all jobs were submitted as card decks at a central counter. The new SPOUT facility permitted upper and lower case printing and handled large-volume card input and punching. There were no interactive systems and, except for eight small-capacity disk drives, all storage was on magnetic tape. No formal consulting service was supplied, and the computer training program had just begun by teaching FORTRAN to 126 scientists.

**1968**
Consulting service (PAL) established
First issue of INTERFACE
Users Guide (standards) published
Shared Direct Access initiated
HASP installed
MFT implemented
First RJE terminal operational
First interactive terminal system—CPS
AGT-30 graphics terminal acquired

**1969**
MVT implemented
WYLBUR service initiated
360/65 installed
DECsystem-10 KA-10 installed
Resource billing initiated
Automatic Documentation Service begun

**1970**
800 BPI to 1600 BPI tape conversion
New 360/65, 1½ million bytes
PTR use initiated

**1971**
Shared Spool implemented
370/165 installed

**1972**
Microfilm/microfiche service begun
DECsystem-10 availability expanded
Omnigraph permitted interactive graphics

**1973**
TSO installed
Data set migration initiated
Remote PTR available

**1974**
DECsystem-10 dual KI-10 installed
Integrated Plotting Package available
Tape library automated
370/168-1 MP installed
Data security/privacy software announced

**1975**
370/168-3 MP installed
Microfiche output for DECsystem-10
Virtual memory for DECsystem-10
NIH5200 terminal developed

**1976**
DECsystem-10 and IBM 370 linked
MVS implemented
Cartridge tape reader available

**1**
*1886—Frank S. Baldwin patented the* Baldwin Calculator. *It was best at addition and subtraction; multiplication and division could be done only indirectly.*

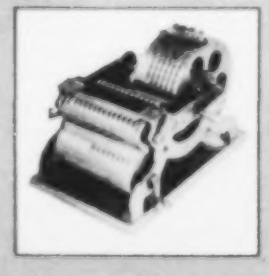
**2**
*1887—Dorr E. Felt developed the first* Comptometer. *It was a multi-order, key-driven adding machine. Two years later the first printing device was added.*

**3**
*1889—Herman Hollerith invented the punch card tabulating system and for the 1890 U.S. Census. The cards were punched on a* pantograph punch, *read by an electric* circuit closing press, *and tabulated on the* electric tabulating machine *which opened the proper door in the top of the* sorting box.

**4**
*1895—John Gore of the Prudential Insurance Company developed a* sorter *for punched cards to aid clerks in calculating insurance premiums.*

**5**
*1900—William S. Burroughs invented the* Burroughs Adding and Listing Machine *which received wide commercial use.*

1



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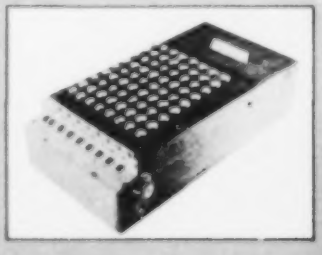

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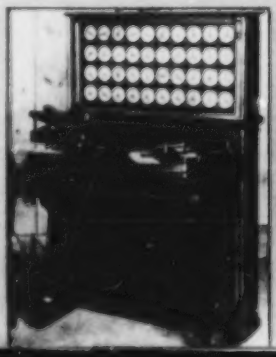

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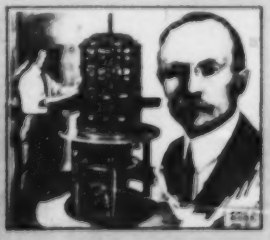

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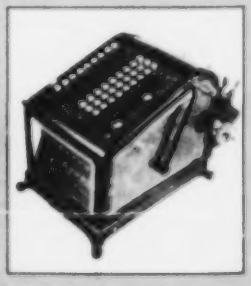


**1977**
Laser printer installed
IMS data base system introduced
SIMULA offered

**1978**
Surface Display System available
CLINK developed
NIH 7000 and T1222 terminals delivered

**1979**
NIH Computer Center designated Federal Data Processing Center (FDPC)
PASCAL available
CT45 terminals delivered
Centrex data switch began service

**1980**
DECsystem-10 Dual KL-10's installed
IBM 3033MP installed

**1981**
NIH Extended WYLBUR implemented
Mass Store Subsystem available

Currently the NIH Computer Utility consists of two major components, the IBM 370 facility and the DECsystem-10. These serve a diverse community of some 8,000 users. Telecommunications has become the predominant means of transmitting work to and from the Utility. More than 650 interactive terminals and 60 high-speed remote batch terminals are served simultaneously. The over 2,000 interactive terminals conduct 6,700 sessions and submit over 9,000 batch jobs daily. Eighty percent of all jobs processed by the Utility are completed and returned to the user in less than two hours, while work which does not require rapid turnaround is completed overnight at a 50% discount. The Information Media Library contains more than 65,000 reels of magnetic tape for offline data storage, and more than 260 disk drives provide direct online access for 200,000 data bases. Several groups are engaged in planning, testing, and implementing enhancements to computer services. A large staff of systems programmers provides telephone and walk-in consulting services and responds to over 150 written requests for assistance every month. The computer training program presents forty different subjects to nearly 2,000 students each year. An inventory of over 600 technical manuals describing all aspects of the Utility is kept on hand, and personal documentation profiles are used to keep each user current on changes in the facilities and services offered by the NIH Computer Utility.

**6**
*1908*—Non-printing Tabulator Type 090. *This was the first machine to sense punched holes electrically and accumulate totals of multi-integer numbers. It had a plug board to permit the operator to change the set-up by altering electric circuits.*

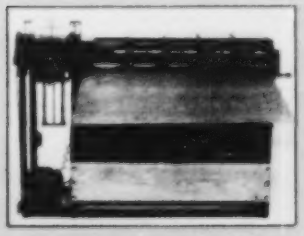
**7**
*1909*—Powers Punch. *James Powers of the Bureau of the Census developed this machine which punched all the holes in a card simultaneously, fed cards automatically, and performed a simple sort. It was used in the 1910 census.*

**8**
*1914*—*E. G. Fischer and R. A. Harris developed a* mechanical analog computer *for the U.S. Coast and Geodetic Survey. It predicted tides on the basis of 37 components, and was in use until 1965.*

**9**
*1920*—*By this time Herman Hollerith had developed the standard-size punched card, incorporated an adding mechanism into his tabulator, installed a flexible plug board so information from any card column could be fed into any register, and developed a compact vertical card sorter.*

**10**
*1923*—IBM Electric Keypunch Type 011. *This was a wholly mechanical keypunch converted for electric operation.*

**6**



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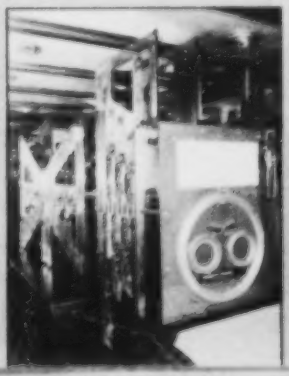

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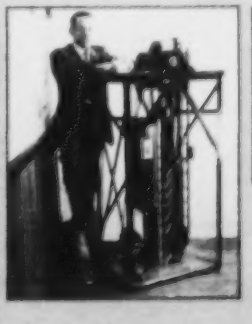

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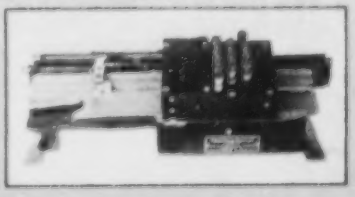

# Structure and Philosophy

With the advent of remote access, the computer has permeated essentially every aspect of the NIH research and management programs. That the computer is a vital tool for medical research is clearly evident from its direct application to a constantly increasing number of new research programs each year. The facilities which have been developed to serve these applications form the multi-system, multi-machine, multi-programming, multi-access, multi-user, and multi-service NIH Computer Utility.

- **Multi-system**
  The IBM 370 and DECsystem-10 facilities offer a choice of environments to meet the unique requirements of individual research activities. Communications facilities permit the automatic transfer of information and programs between the two systems.

- **Multi-machine**
  Each major system has a number of central processors serving as subsystems. This design permits the workload to be dynamically shifted to another machine and service to be continued with minimal interruption in the event of failure of an individual component.

- **Multi-programming**
  Each subsystem can handle many tasks simultaneously. Sophisticated control programs allot to each job only the resources it needs. Interactive and timesharing systems function as single tasks while at the same time providing responsive service to hundreds of individual users.

- **Multi-access**
  Development of diverse methods of remote access has brought the power of the computer directly into the offices and research laboratories of the NIH. Over two thousand interactive CRT's and hard copy terminals are used to access the Utility via the standard telephone network. Access to the Utility is also provided for minicomputers located in research laboratories where they control and record the results of real-time scientific experiments.

**11**
*1925*—IBM Horizontal Sorter Type 080. *This machine operated at a speed of up to 400 cards per minute for each column sorted. It was twice as fast as earlier vertical models.*

**12**
*1930*—*Vannevar Bush at M.I.T. developed the first* differential analyzer, *an analog computer used to predict power surges. It was accurate within .05 percent. A later model used paper tape input to set the gear ratios and connections needed for a particular problem. In 1935 he developed a more general machine using electrical components.*

**13**
*1937*—*Howard Aiken of Harvard University proposed development of an automatic general purpose digital calculator. Developed by IBM, the* Automatic Sequence Controlled Calculator, *known as the* Mark 1, *was the largest electro-mechanical computer ever built. It was completed in 1944.*

**14**
*1946*—ENIAC (*Electronic Numerical Integrator and Computer*) *completed. J. Presper Eckert and John W. Mauchly of the Moore School of Engineering at the University of Pennsylvania developed the first digital electronic computer. It used 18,000 vacuum tubes and required rewiring to change programs. It was developed for the U.S. Army's Ballistic Research Laboratories at Aberdeen, Maryland.*

**15**
*1947*—Whirlwind I, *developed for the U.S. Navy by Jay W. Forrester and the Digital Computer Laboratory at M.I.T., was the first computer to make use of magnetic cores for memory and the first to use the parallel synchronous method for handling information inside the machine. It began its task of identifying hostile aircraft from radar information in 1958 after 1800 man-years of programming effort.*

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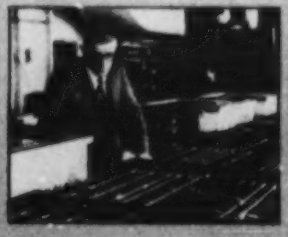

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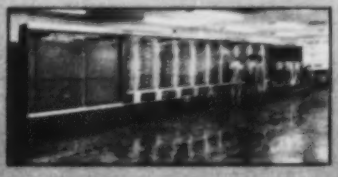

14.

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- **Multi-user**
  The community of users served by the NIH Computer Utility is uniquely diverse. It includes medical researchers, clinicians, engineers, administrators, statisticians, programmers, clerks, and secretaries. Instead of designing a limited specific service for each type of customer, the Computer Center has chosen to provide a general purpose utility, making the broadest range of full-power computer services available to every user. This utility concept is particularly beneficial for groups whose need for computational power is increasing. As their need and ability to use the Utility grow, they find that the expanded resources they need are already available.

- **Multi-service**
  The Utility offers the fullest possible complement of computer-based services:

  Batch processing
  Remote job entry
  Timesharing
  Interactive text editing
  Data base management
  Online graphics
  Paper tape reading
  Cataloged procedures
  Program libraries
  Tape storage
  Online disk storage
  Automatic data migration
  Computer output/microfiche
  Custom printing
  Plotting services

Utilizing the various multi-features to best advantage, the resulting complex appears to the user as a single uninterruptable source of computational potential to be applied to the

**16**
*1948—SSEC (Selective Sequence Electronic Calculator) was developed by IBM under the direction of Wallace J. Eckert, head of the Watson Scientific Computing Laboratory. It was the first machine that could do conditional branching.*

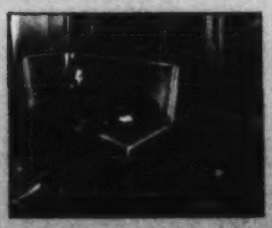
**17**
*1949—SEAC (Standards Eastern Automatic Computer) completed by the National Bureau of Standards. It was the first stored program computer in operation in the U.S. It used mercury delay lines for its serial memory. Later an early magnetic tape unit was used to expand the 512 word memory; instead of being collected on a reel, the tape was spilled into two glass-sided tanks.*

**18**
*1951—EDVAC (Electronic Discrete Variable Automatic Computer) completed at the University of Pennsylvania. It was built during the years 1946–1949 for the Ballistics Research Laboratory. The stored program design for computers was first proposed and worked out for this machine. It used acoustic mercury delay lines for memory and contained 4000 tubes and 10,000 diodes.*

**19**
*1952—*I.A.S. computer, *developed by John von Neumann at the Institute for Advanced Study, was completed. It used Williams cathode ray tubes for memory and parallel binary arithmetic. It was a forerunner of similar systems such as:* ILLIAC, GEORGE, JOHNNIAC, MANIAC, ORACLE, *and* ORDVAC.

**20**
*1954—*UNIVAC I, *the first commercial computer, was delivered to General Electric by Sperry Rand Corporation. The original UNIVAC I was delivered to the Bureau of the Census in 1951; it was the first machine to use magnetic tape for storage.*

**16**



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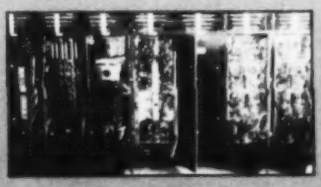

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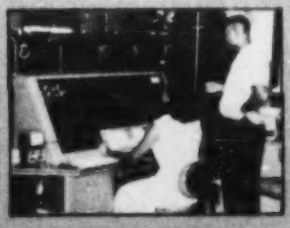

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problems of modern medical research and administration. Like any utility, whatever power or capability is required can be dynamically added to—or removed from—the Utility to meet changing demands without a break in services and without expensive and time-consuming reprogramming effort. The architecture of the NIH Computer Utility provides for this without interruption or degradation of any essential on going service.

Unlike most government installations, the NIH Computer Center operates strictly on a fee-for-service (cost-recovery) basis; that is, its income is derived solely from its customers who pay only for the services they use. The Computer Center's continued existence and growth depend on its ability to supply the computer services its customers need at a cost they feel is reasonable for the service received. This financial structure insures that the Center will be responsive to the needs of its users and that it will constantly strive to maintain the most efficient and effective operation possible. As the Utility has grown in size and scope, the average cost per unit of work has been reduced by a factor of ten while the services offered, responsiveness, and reliability have increased by many orders of magnitude.

Responsiveness to the needs of its customers has prompted the Computer Center to develop a full range of people-oriented services to facilitate use of the Utility. An extensive training program, telephone and walk-in consulting services, and automatic documentation distribution are the major components of this effort. For everyone from the secretary with no computer knowledge to the scientist with years of experience in the field, there are courses to learn from, consultants to ask for help, and manuals to use for reference.

**21**
*1954—IBM 650 introduced. This relatively small computer was very popular, and over 1000 were installed—one at NIH in 1958.*

**22**
*1956—IBM 704 designed by Gene Amdahl. This was the first commercial machine to offer floating point arithmetic and index registers and it had the first reliable core memory (up to 32K). FORTRAN, the first compiler language, was developed for use on this machine.*

**23**
*1957—MOD I, developed by Burroughs, was the first operational computer to use transistors. It provided guidance for Atlas ICBM's.*

**24**
*1958—RCA 501 was an early transistorized computer with the first available COBOL compiler.*

**25**
*1959—IBM 7090 was first delivered to the Ballistic Missile Early Warning System (BMEWS). It inaugurated the very popular 7090 series of transistorized computers.*

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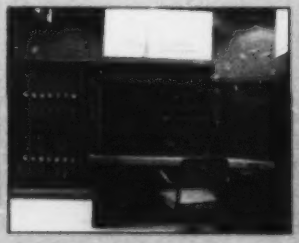

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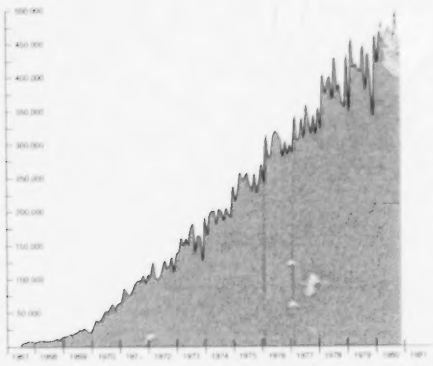
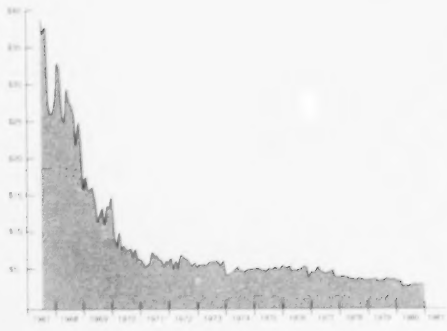
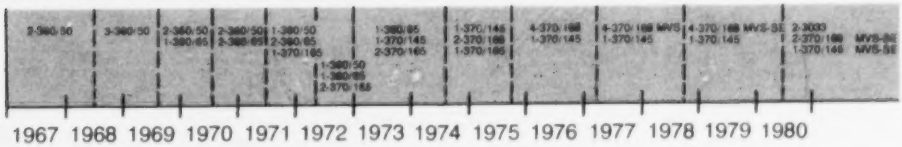
**Jobs and Interactive Sessions (Per Month)**



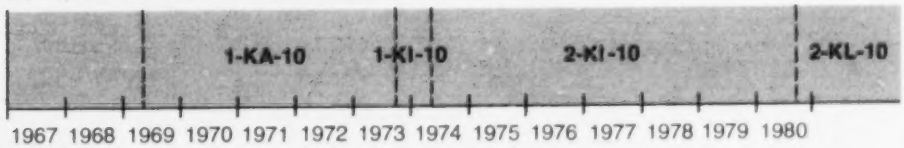
**NIH Computer Center Average Cost Per Job**



**IBM 360 and 370 Machine Installations**




**DECsystem 10 Machine Installations**




**26**
*1960—PDP–1 was developed by Kenneth Olsen of Digital Equipment Corporation. It was the first commercial computer designed for real-time monitoring of experimental laboratory data.*

**27**
*1960—*Honeywell 800. *This parallel machine was capable of handling up to eight programs simultaneously without the need for special programming. This computer was used at NIH from 1962–1967.*

**28**
*1963—PDP–5. This was the first commercially available minicomputer. It was designed to permit a researcher to connect a relatively inexpensive computer to an instrument for full-time dedicated operation.*

**29**
*1963—*Burroughs 5500. *This was the first commercially available computer to offer virtual storage.*

**30**
*1964—*IBM 360's, *the first family of fully compatible computers, were introduced. They were "third generation" computers since they used integrated circuits.*

**26**

**27**

**28**

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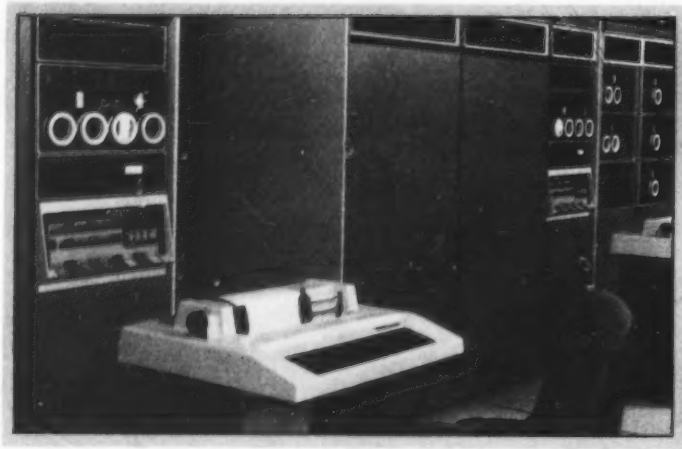
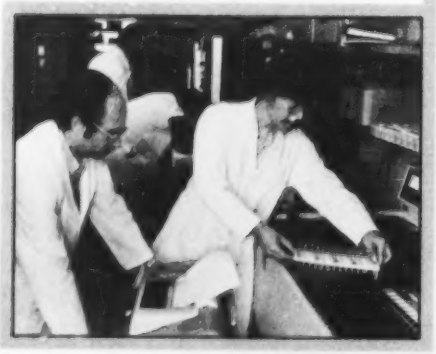
## Today the Computer Utility Serves NIH





# ORGANIZATION

**User Services and Assistance** is the primary interface between users and the IBM 370 facility. Consultation services are provided by the Programmer Assistance and Liaison Unit. The Operating Systems Support Unit increases the reliability of the system by testing and installing problem "fixes" and improvements. The Computer Training Program is planned and coordinated by the Training Unit. The Technical Information Office distributes publications describing the services and facilities of the Computer Utility and provides many support services to the Computer Center's educational program.

**Systems Research and Development** is responsible for the design and implementation of new facilities and services to meet the unique needs of users of the NIH Computer Utility. The General Systems Unit and the Interactive Subsystem Development Unit do software design and operating system development for the IBM 370 facility. The Data Base Systems Unit provides consultation and maintains data base systems for customers who need to access and manipulate large data files on a real-time basis. The Laboratory Systems Unit provides all systems development and user support services for the DECsystem-10.

**Operations** maintains and operates all computers and ancillary equipment for the Computer Utility. Smooth running of the system and uninterrupted service are assured by Computer Operations. Output Distribution Services distributes output directly to users and through the U.S. Postal Service. The Information Media Library maintains a record of the assignment of all offline magnetic tapes and disks and keeps records on over 200,000 online user-owned data sets; it provides a weekly record of current holdings for each individual user. Data Entry Services stores data via WYLBUR on disk and via a keydisk machine on standard-labeled magnetic tape. Data entry needs which cannot be met in-house are handled by Contract Data Entry. Plotting Services runs an offline plotter to provide high-quality graphic output. Dedicated Equipment Services arranges for the timely delivery and installation of terminals in users' offices and laboratories and handles all terminal repairs and telephone line problems that may arise during their use.

**Program Support** provides programming maintenance services. The responsibility is divided between the Administrative Systems Support Unit and the Scientific Systems Support Unit.

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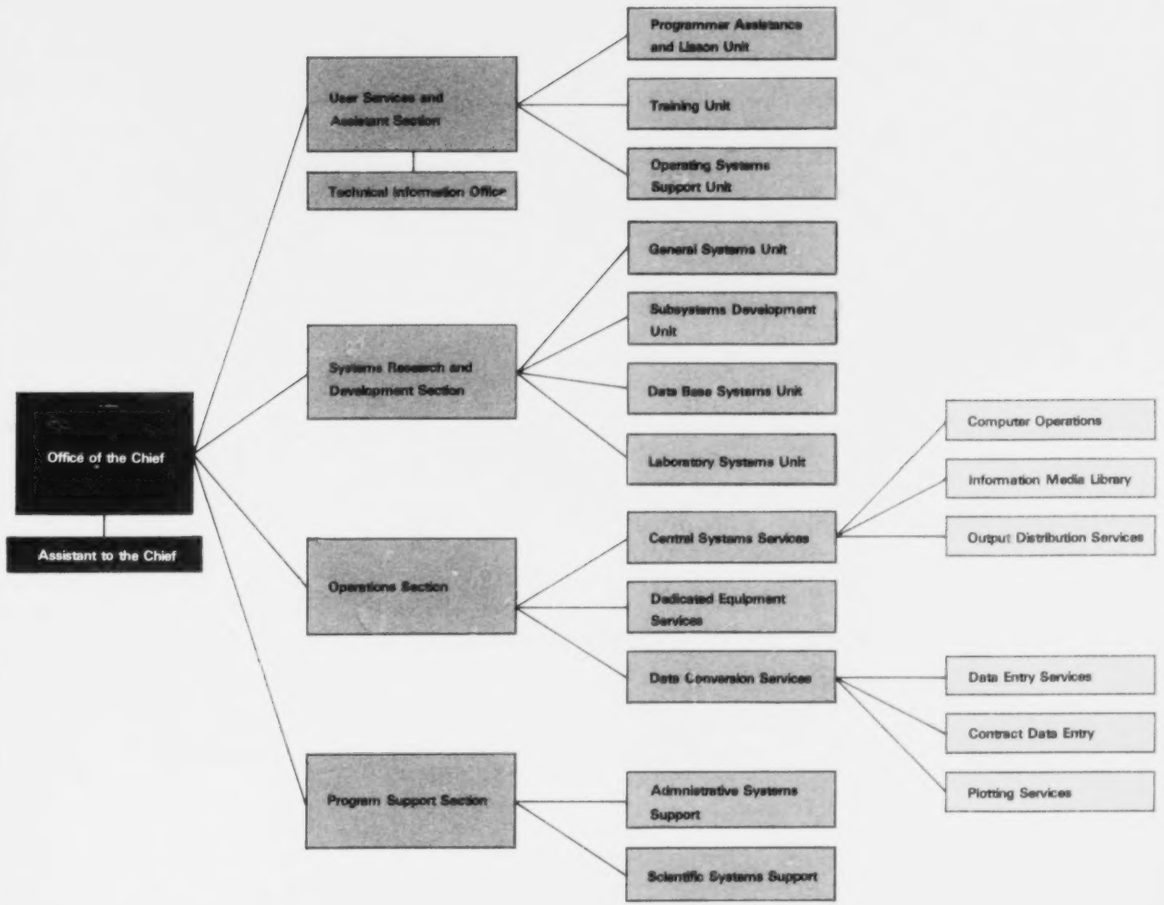
# ORGANIZATION



# IBM 370 Service Charges

Processing services are provided on the IBM 370 facility at an audited rate of $.50 per machine unit with a minimum charge of $.25. In line with the Computer Center's policy of keeping users fully informed of computer costs as they are incurred, charges are reported at the end of each terminal session and on the printed output from each batch job.

Please note that the following figures are accurate for the second quarter of 1981. Since the facility is in an active phase of development, they may quickly become outdated.

Batch charges are computed in the following way:

MU = (1 + .371D + .0196T + .0012R) (N*C + .00017) + .00174U

*where*

MU = machine units
D = number of disk drives
T = number of tape drives
R = region size in K units
N = .3 for the 370/168-3
.6 for the 3033
C = CPU time in seconds
I = I/O count
U = unit record transfers (cards read + cards punched + lines spooled or transmitted)*

*Effectively $.87/1000 for such transfers.

There is a 50% rate reduction for all jobs executed between the hours of 6:00 p.m. and 6:00 a.m. weekdays and all day on weekends.

**STORAGE**

The charge for online disk storage is $.015 per track day (13,030 bytes). A dedicated online disk is $1658.00 per month. Rental of a mountable disk is $25.00 per month.

Tape rental is $1.00 per month (or any fraction thereof), and there is a $15.00 charge to remove a tape permanently from the library.

**INTERACTIVE TERMINAL SESSIONS**

**WYLBUR**

$ .70 per second for editing time
$2.00 per hour for terminal connect time

**TSO**

$ .55 per second for CPU time
$ .02025 per 100 I/O count
$ .87 per 1000 unit record transfers
$2.00 per hour for terminal connect time

Charges for TSO and WYLBUR are reduced by 50% for any session that is active between 6 p.m. and 6 a.m. weekdays and all day on weekends.

**OFFLINE PRINTING**

Charges for SPOUT (a processor which handles some special printing and punching) are computed using the following formulas. The minimum charge for any SPOUT job is $2.43.

**Print**

$ = .87 × lines printed/1000 × train + 2.43 × G + Q
train = 1 for SN
1.5 for all others
G = 1 for each group of control records
Q = 17.00 if a QUALITY control record is included

**Punch**

$ = .87 × cards punched/1000 × 1.5 + 2.43 × G
G = 1 for each group of control records

**MICROFICHE**

105 mm microfiche
$ = fiche × $2.08 + C × $2.43

Where "C" in the above formula is the number of control records requiring operator action. They are:
Inserting forms slides for forms flashing
Lens change (42X to 24X or 48X)

Charges for silver halide copies are the same as for originals except there is no additional charge for control records.

Duplicates (thermal)
105 mm microfiche
$ = fiche × $.25

# DECsystem-10 Service Charges

Timesharing services are provided on the DECsystem-10 facility at an audited rate of $1.15 per machine unit computed by the following algorithm:

MU = 14(13.6 + .3T + .5D + .017R) (1.65C + .031E)

*where*
MU = machine units
T = number of magnetic tapes mounted
D = number of private disks mounted
R = (4 times region size in DECsystem-10 words)/1024
C = CPU time in minutes
E = (number of disk blocks written + number of disk blocks read)/100

The processing charge is reduced by 50% for charges accumulated between the hours of 6:00 p.m. and 6:00 a.m. weekdays and all day on weekends.

**ADDITIONAL CHARGES**
Online disk storage = $0.10 per day/100 blocks
Terminal connect time = $2.00 per hour
Spooling = $0.035 per page

# Peripheral Charges

**Plotting Facility**
The charge for use of the CalComp Plotter is $30.00 per hour.

**Evans & Sutherland System**
The charge for use of the PDP-11/70 is $37.50 per connect hour.

**Data Entry Services**
The charge for data entry services is $10.00 per hour.

**Dedicated Hardware**
Dedicated hardware (such as interactive terminals, RJE workstations, etc.) is billed at cost.

## OPERATING SCHEDULES

### IBM 370

| | |
|---|---|
| Batch Processing | |
| Monday-Saturday | 24 hours |
| Sunday | 8:30 a.m.-4:00 p.m. |
| Interactive Services (TSO, WYLBUR) | |
| Monday-Saturday | 8:00 a.m.-12 midnight |
| Sunday | 8:30 a.m.-4:00 p.m. |
| Discount Service | |
| Monday-Friday | 6:00 p.m.-6:00 a.m. |
| Saturday | 24 hours |
| Sunday | 8:30 a.m.-4:00 p.m. |

The weekend service hours given above may be disrupted or changed when necessary for hardware or software maintenance.

### DECsystem-10

| | |
|---|---|
| Monday-Friday | 8:00 a.m.-12:00 midnight |
| Saturday | 8:00 a.m.-4:00 p.m. |

Unattended timesharing is available after midnight and on weekends unless preempted for system maintenance.

| | |
|---|---|
| Discount service | |
| Monday-Friday | 6:00 p.m.-6:00 a.m. |
| Saturday, Sunday | 24 hours |

## CONSULTATION

Users of the IBM 370 facility come to the Programmer Assistance and Liaison (PAL) Unit for aid and assistance in debugging programs. The PAL Unit also investigates problems users may encounter because of system hardware or software failures and arranges for users to obtain refunds when appropriate. The systems programmers who staff this unit can also advise customers who are planning to design or acquire new software packages. In addition to helping individuals directly, the PAL Unit informs the user community as a whole of solutions to temporary software problems and the best ways to use new facilities.

Tutorial assistance, for those who need more detailed help, is provided by the Training Unit.

The Laboratory Systems Unit offers similar consultation and assistance for users of the DECsystem-10.

## INFORMATION

The Technical Information Office distributes written information about the services and activities of the Computer Center to its users, and to the interested community at other computer centers throughout the world. Each customer has a personal documentation profile and automatically receives copies of needed publications whenever they are revised.

## EDUCATION

The Training Unit coordinates courses designed to assist users in making more effective and efficient use of the NIH Computer Utility. Topics range from introductory courses and programming languages to advanced seminars on the applications of computers in specific areas of biomedical research. Courses are offered on a term basis, with four terms each year. The regular program is supplemented by independent study courses which students can arrange to take at their own convenience.

## USER AREA

A user work area furnished with desks, interactive terminals, graphics terminals, and a remote batch terminal (IBM 3777) is provided for the convenience of customers who visit the central facility.

## DATA STORAGE FACILITIES

The NIH Computer Utility provides a full range of disk and tape storage facilities. Data stored on an online disk is immediately available while long-term storage of large, infrequently-accessed data bases is most economically done on magnetic tape. Automatic data set migration moves inactive online disk data sets to tapes from which they can easily be retrieved on demand.

Disk Storage. The IBM 370 facility provides three types of online disk storage. The FILE packs are used to store small and medium size data sets. PDS packs store large partitioned data sets while the TMP packs provide short-term storage. Users with requirements for massive amounts of disk storage can arrange to have an online or mountable disk reserved for their private use. The DECsystem-10 provides each user with a "disk area" for creating and maintaining data files.

Tape Storage. The Information Media Library maintains a large supply of magnetic tapes. The majority of these are 9-track 1600 BPI tapes. 9-track 6250 BPI tapes are available for disk backups. 9-track 800 BPI and 7-track tapes are kept to provide for easy exchange of data with other computer installations.

**REMOTE JOB ENTRY**
The NIH Computer Utility offers users the ability to submit batch jobs from interactive keyboard terminals and from high-speed remote batch workstations. Job status can be checked from either type of terminal and, when a job is completed, its output can be produced at any convenient terminal or at the central facility. Job output can be routed to any high-speed remote terminal connected to the system, anywhere in the country.

**LABORATORY SYSTEMS INTERFACE**
Mini/microcomputers in laboratories can take advantage of the resources of the central system. Data exchange can be performed using communications links and interchangeable media. Cross-compilers facilitate development of software for minicomputers.

**TERMINAL PROCUREMENT AND REPAIRS**
Users may order interactive terminals and remote batch workstations through the Computer Center. Dedicated Equipment Services will insure prompt delivery, compatibility with the Utility's systems, and correct installation and will handle any repair problems which may arise during use.

**CUSTOM PRINTING**
Printing services range far beyond the standard upper and lower case printing on lined computer paper. A variety of forms, from letterhead and three-hole-punched notebook paper to pre-gummed labels, is provided. Document preparation services allow printing of special characters. Greek letters, chemical symbols, superscripts, and subscripts. In addition, users may have their own custom-designed forms stocked for printing.

**MICROFICHE**
For users with high volume output, microfiche offers many advantages over paper output. It is cheaper to produce, easier to access, and can be handled, mailed, and stored more easily since it is fifty times more compact. Microfiche can be generated with visible titling and indexing.

**GRAPHICS**
A PDP-11/70 connected to the DECsystem-10 supports a high quality line-drawing display, a high resolution color video display, and a 35 mm camera station for capturing graphical images on film.

**DATA ENTRY**
Data preparation services include key-to-disk service and key-to-tape service. Decollating and bursting services for computer-generated reports and assistance to users in designing questionnaires and coding froms for data entry are also available.

**PLOTTING**
An offline tape-driven 34-inch CalComp plotter (925/1036) produces high-resolution multi-color output from data generated by the DECsystem-10 or the IBM 370's. The DECsystem-10 offers several attractive online graphics facilities. Special software and terminals make it possible to do interactive curve fitting, make three-dimensional projections of molecules, and direct graphic output to a variety of devices without reprogramming. Graphic output may also be directed to microfiche.

# IBM 370 Software

The software servicing the IBM 370 system is composed of the IBM MVS (Multiple Virtual Storage) operating system and a highly/customized version of JES2 (Job Entry Subsystem 2) which incorporates the NIH-developed Shared Spool capability. This complex operating system presents a unified system interface to the user. It inherently provides automatic load balancing and fail-soft capability and controls the concurrent execution of up to 75 batch jobs. Coexisting with the batch processing facilities are:

**WYLBUR** — an interactive text editor, document formatter, command processor, and remote job entry facility supporting over 450 simultaneous keyboard terminals.

**TSO** — a general purpose timesharing system which permits interactive programming in FORTRAN, COBOL, PL/I, VS BASIC, and Assembly language, as well as SPEAKEASY. Offering conversational access to the facilities of OS/370, TSO supports up to 120 concurrent terminal sessions.

**IMS** — an information management system for interactive interrogation and maintenance of large centralized data bases (restricted access).

**Supported language processors include:**
FORTRAN G1
FORTRAN (H extended)
WATFIV
PL/I Optimizing Compiler
PL/I Checkout Compiler
VS COBOL
Assembler F
Assembler G

**Other supported software:**
Linkage Editor
Loader
Sort/Merge
Microfiche package (EZFORM/PTFORM)
Integrated Plotting Package
Certain vendor-supplied utilities
NIH-written utility programs

# DECsystem-10 Software

The DECsystem-10 timesharing system runs under the TOPS-10 Monitor permitting virtual memory utilization. The online file system allows dynamic file allocation and multi-level file protection. The system is configured to service up to 60 terminal users simultaneously. The flexible terminal interface provided by the DECsystem-10 includes 29 software parameters which, combined with a variety of terminal speeds and modems, support most types of interactive terminals.

Laboratory computer support includes cross-compilation and linking, simulation, and data transport. Remote computer support uses 6 different protocols ranging from easily implemented, simple protocols to a full networking connection.

Graphics software services 8 types of display terminals and 3 different plotting devices. Available graphics programs provide mathematical modeling and curve-fitting and digitizing of graphic input.

The more important software systems available include:

**OMNIGRAPH** — an NIH-developed device-independent interactive graphics system. Usable from SAIL, FORTRAN and BASIC. Omnigraph provides 2D windowing, 3D pyramid clipping, and complete transformation capabilities in both 2D and 3D.

**SOS** — a line-oriented text editor

**SAIL** — an ALGOL dialect compiler with flexible string processing and I/O capabilities

**APLSF** — a concise mathematical/statistical programming language

**FORTRAN-10** — a mathematical programming language

**BASIC** — a simple algorithmic language

**ALGOL** — a standard ALGOL compiler

**PASCAL** — a portable structured programming language

**MACRO-10** — DECsystem-10 assembly language

**LINK-10** — linkage editor/loader with overlay capability

**PUB** — a document compiler

**GALAXY** — DECsystem-10 spooling and batch system

**MERCURY** — program for data and job transfer between DECsystem-10 and IBM 370

**SPELL** — a spelling checker/corrector

Online Mail and Teleconferencing Systems for project collaboration
Online Debugging Packages for SAIL, FORTRAN, and MACRO.

**CLINK** — File transfer to and from laboratory PDP-11 computers

**MLAB** — Online mathematical modeling and 3-D graphics system

**CLAB** — Clustering analysis package

## IBM 370 Hardware Configuration

The IBM System 370 facility is an integrated system composed of a network of processors interconnected by shared direct access storage devices. The processing units currently employed include:

1 370/3033 MP with 2 processors sharing 16 million bytes of storage
1 370/168-3 MP with 2 processors sharing 12 million bytes of storage
1 370/145-1 with 2 million bytes of storage

The 370/3033 MP system has six byte multiplexor and twenty-six block multiplexor channels. The 370/168MP system has four byte-multiplexor and twenty block-multiplexor channels. The 370/145 has one byte-multiplexor and four block-multiplexor channels. These subsystems are interconnected by over 200 spindles of shared direct access storage devices allowing interprocessor communication.

Where possible, all devices have the capability of switching to one or more subsystems, thus providing non-idle redundancy. This switching allows minimal disruption of service in the event of a subsystem or component failure.

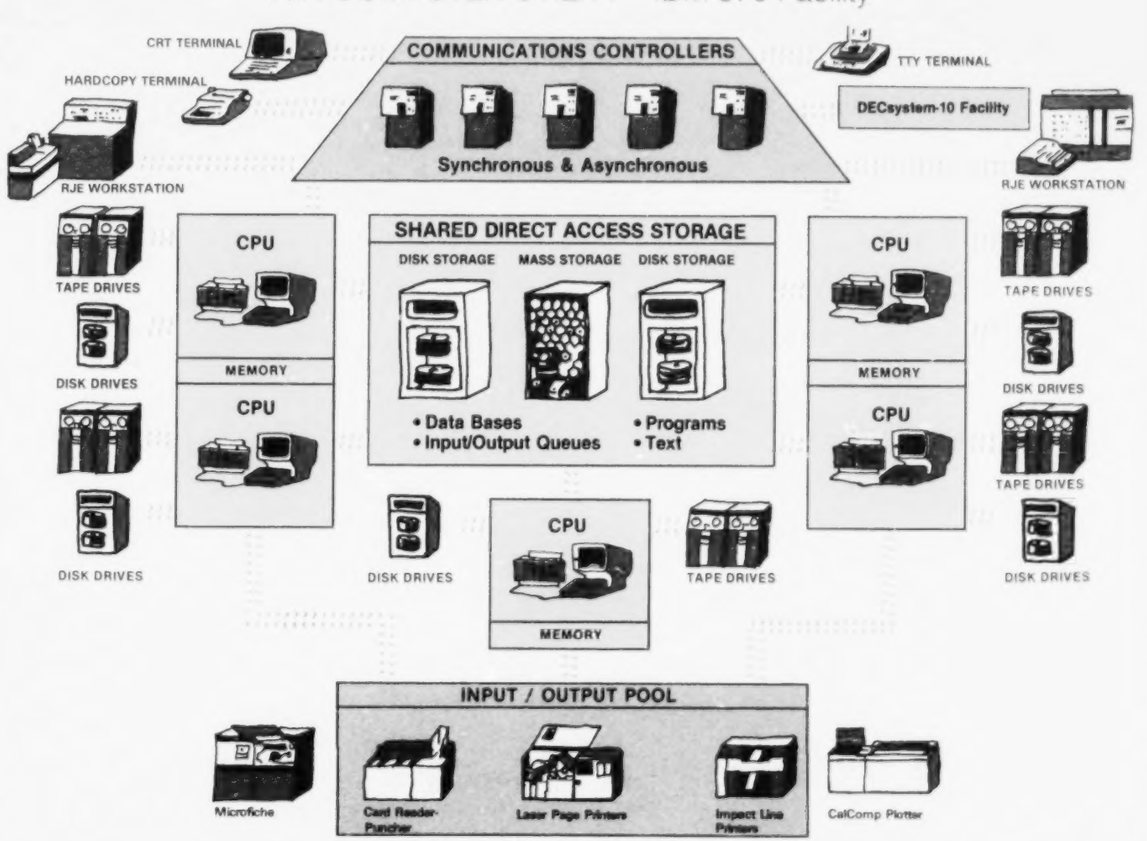
The I/O device complement includes:

| | |
|---|---|
| 3705 | communication control units for keyboard terminals (10, 13.5, 30, 120 CPS) and RJE workstations (600, 1200 CPS) |
| 2420-5 | tape drives (1600 BPI) |
| 2401-3 | tape drives (7 and 9 track) |
| 3420-6 | tape drives (6250 BPI) |
| 3330 | disk storage facilities |
| 3850 | mass storage subsystem |
| 3800 | printing subsystems |
| 1403-N1 | printers |
| 2540 | card reader/punches |

Special purpose offline output devices include:

| | |
|---|---|
| SD-4561 | microfiche recorders |
| 925/1036 | CalComp plotter |

NIH COMPUTER UTILITY—IBM 370 Facility

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# DECsystem-10 Hardware Configuration

The DECsystem-10 timesharing system consists of dual processors sharing the same memory. The processing units employed are:

2 KL-10 processors
1024K 36 bit words of memory

The peripheral devices include:

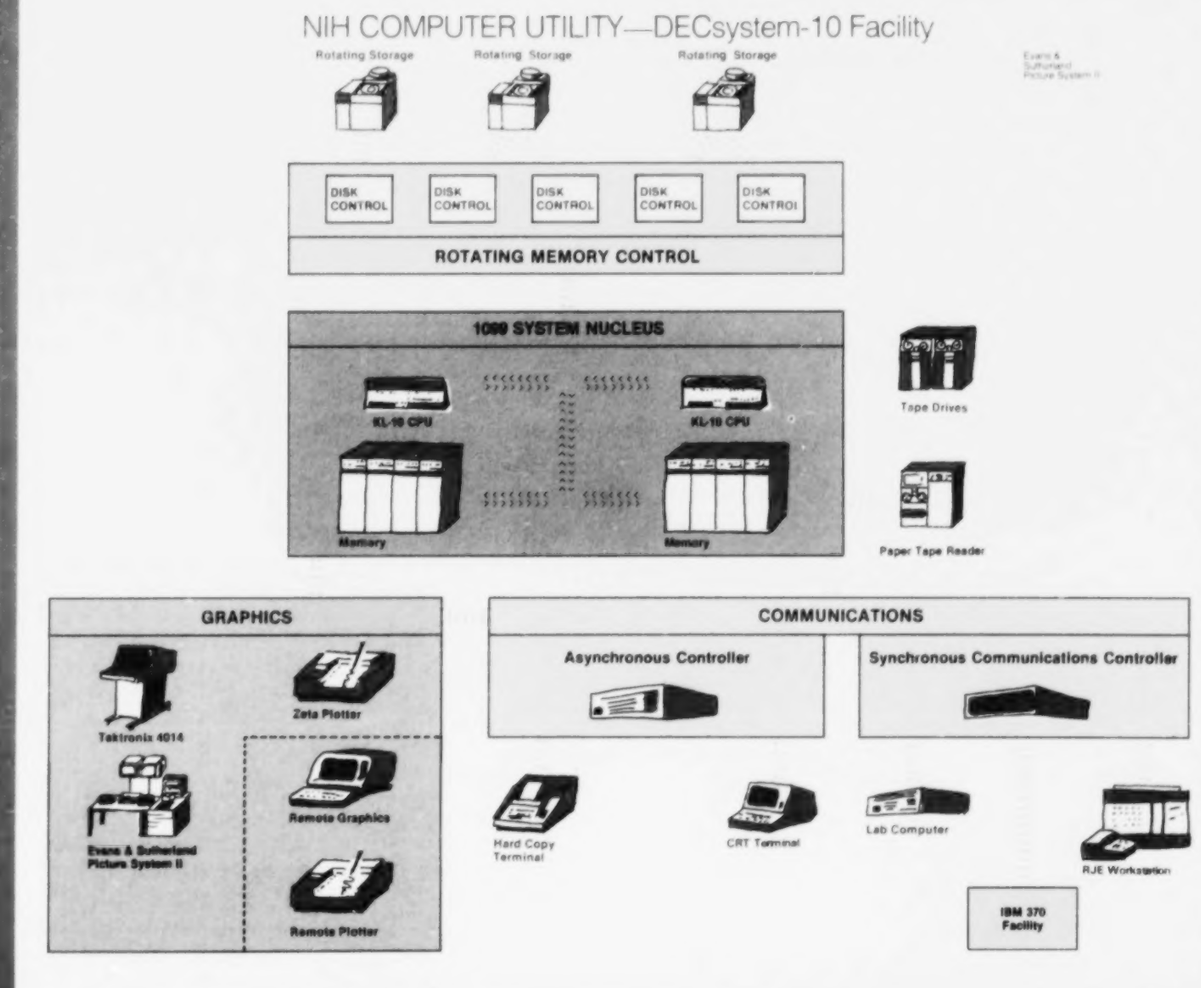
RP06 disk drives
TU72 tape drives (9 track, 1600/6250 BPI)
DEC LP07 line printer
REMEX paper tape reader

Graphics equipment:

Evans & Sutherland Picture System II, frame buffer, and camera station
GT40 display
Tektronix 4014 display
ZETA Plotter

Communications equipment:

DN20, DN25 communications interfaces

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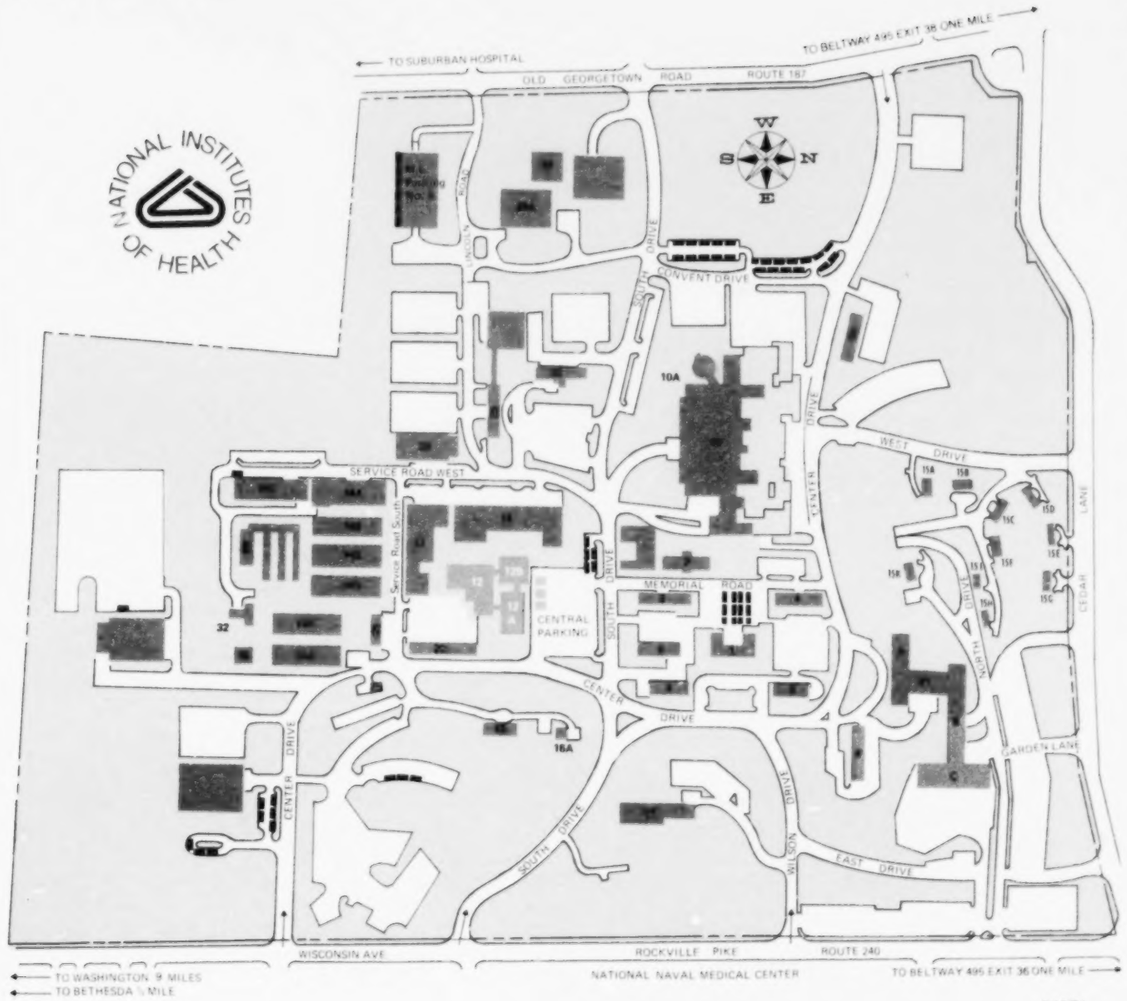
COMPUTER FACILITY

OTHER BUILDINGS

VISITOR PARKING

LOADING ZONE

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